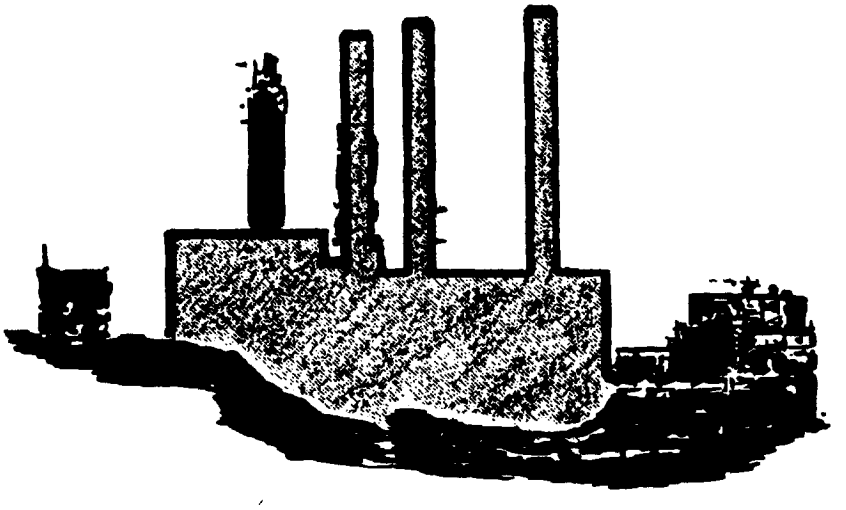
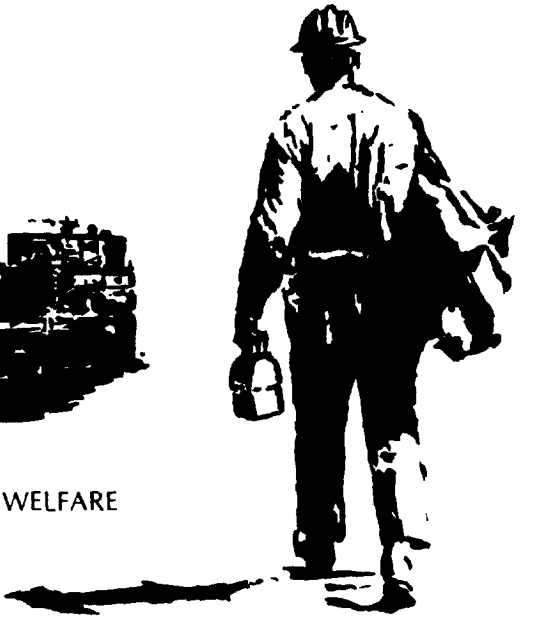
NIOSH

CRITERIA FOR A RECOMMENDED STANDARD....

OCCUPATIONAL EXPOSURE TO

HYDRAZINES





U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

criteria for a recommended standard....

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PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and provide for the safety of workers occupationally exposed to an ever-increasing number of potential hazards. The National Institute for Occupational Safety and Health (NIOSH) evaluates all available research data and criteria and recommends standards for occupational exposure. The Secretary of Labor will weigh these recommendations along with other considerations, such as feasibility and means of implementation, in promulgating regulatory standards.

NIOSH will periodically review the recommended standards to ensure continuing protection of workers and will make successive reports as new research and epidemiologic studies are completed and as sampling and analytical methods are developed.

The contributions to this document on hydrazines by NIOSH staff, other Federal agencies or departments, the review consultants, the reviewers selected by the Society of Toxicology and the American Industrial Hygiene Association, and Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, are gratefully acknowledged.

The views and conclusions expressed in this document, together with the recommendations for a standard, are those of NIOSH. They are not necessarily those of the consultants, the reviewers selected by professional societies, or other Federal agencies. However, all comments, whether or not incorporated, were considered carefully and were sent with the criteria document to the Occupational Safety and Health Administration for consideration in setting the standard. The review consultants and the Federal agencies which received the document for review appear on pages v and vi.

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Acting Director, National Institute
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The Division of Criteria Documentation and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for the development of the criteria and recommended standard for hydrazines. Imogene F. Sevin, Ph.D., of this Division served as criteria manager. SRI International developed the basic information for consideration by NIOSH staff and consultants under contract CDC-99-74-31.

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I. RECOMMENDATIONS FOR A HYDRAZINES STANDARD

NIOSH recommends that employee exposure in the workplace to hydrazine, methylhydrazine, 1,1-dimethylhydrazine, 1,2-dimethylhydrazine, and phenylhydrazine, and their salts formed by addition with acids, such as sulfates, hydrochlorides, or hydrobromides, be controlled by adherence to the following sections. The standard is designed to protect the health and provide for the safety of employees for up to a 10-hour workshift, 40-hour workweek, over a working lifetime. Compliance with all sections of the standard should, as a minimum, substantially reduce the risk of cancer induced by these hydrazines and prevent other adverse effects, both acute and chronic, which could result from exposure in the workplace. Sufficient technology exists to permit compliance with the recommended standard. The employer should regard the recommended environmental limits as the upper boundaries of exposure and make every effort to maintain the exposure as low as is technically feasible. The standard will be subject to review and revision as necessary.

The recommended standard is based on the conclusion that valid evidence of skin absorption, blood and liver effects, and tumor induction in experimental animals by these hydrazines is relevant to human exposure. No demonstrably safe level of exposure is evident, and in view of the severity of the toxic effects, especially carcinogenicity, the limits of exposure recommended represent the lowest detectable concentrations. The environmental limits are likely to offer greater protection from nonneoplastic effects from some hydrazine compounds than from others. They

assure protection to individual compounds only when skin absorption is prevented and they cannot be directly extrapolated to mixtures.

The criteria and recommended standard apply to exposure of workers to hydrazine and its derivatives, methylhydrazine, 1,1-dimethylhydrazine, 1,2-dimethylhydrazine, and phenylhydrazine, and their salts. The term "hydrazines" will be used throughout the document to mean all five compounds and their salts unless a compound is referred to specifically. Common synonyms used for methylhydrazine are monomethylhydrazine and MMH; for 1,1-dimethylhydrazine, unsymmetrical or asymmetrical dimethylhydrazine and UDMH; and for 1,2-dimethylhydrazine, symmetrical dimethylhydrazine and SDMH. "Occupational exposure to hydrazines" is defined as work in any area where one or more of the hydrazines is stored, produced, processed, transported, handled, or otherwise used and present in such a manner that vapors or aerosols may be released in workroom air or that the materials may spill or splash onto the skin or into the eyes.

Section 1 - Environmental (Workplace Air)

(a) Concentrations

Occupational exposure to hydrazines shall be controlled so that employees are not exposed at concentrations greater than those specified below, expressed as milligrams of the free base per cubic meter of air (mg/cu m), determined as ceiling concentrations in any 2-hour period:

hydrazine	- 0.04 mg/cu m (0.03 ppm)*
methylhydrazine	- 0.08 mg/cu m (0.04 ppm)
1,1-dimethylhydrazine	- 0.15 mg/cu m (0.06 ppm)
phenylhydrazine	- 0.6 mg/cu m (0.14 ppm)

*Approximate equivalents in parts of free base per million parts of air (ppm).

These recommended limits are the lowest concentrations measured by the recommended method of analysis with an analytical precision of at least 15%. No limit is recommended for 1,2-dimethylhydrazine, since an acceptable method of sampling and analysis is presently unavailable.

(b) Sampling and Analysis

Samples in the work environment shall be collected and analyzed according to the procedures described in Appendix I or by any methods at least equivalent in precision, accuracy, and sensitivity.

Section 2 - Medical

Medical surveillance shall be made available as outlined below to all persons subject to occupational exposure to hydrazines.

(a) Preplacement medical examinations shall include at least:

(1) Comprehensive medical and work histories.

(2) Comprehensive physical examination.

(3) Specific clinical tests including complete and differential blood count; liver function tests including serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT); urinalysis including specific gravity, glucose, protein, and microscopic examination; and a 14- x 17-inch posteroanterior chest roentgenogram.

(4) A judgment of the worker's ability to use positive pressure respirators.

(5) Urobilinogen and serum bilirubin tests shall be considered by the responsible physician.

(b) Periodic examinations shall be made available at least annually to those working with hydrazines. These examinations shall include at least:

(1) Interim medical and work histories.

(2) Physical examination as outlined in paragraphs (a)(2), (a)(3), and (a)(5) of this section. In addition, for workers over the age of 40, proctosigmoidoscopy shall be made available to those exposed to 1,2-dimethylhydrazine, and it should be considered for those exposed to other hydrazines.

(c) In view of the numerous body systems in which toxic effects of hydrazines have been demonstrated, medical and work histories and physical examinations should be thorough and should give particular attention to combinations of signs or symptoms, including evidence of dermal contact, that may indicate toxicity.

(d) In the event of an illness caused by exposure to hydrazines, appropriate medical services shall be made available.

(e) In an emergency involving massive exposure to the hydrazines, either by inhalation or dermal contact, immediate medical attention and appropriate followup medical care shall be provided.

(f) Pertinent medical records shall be maintained for all employees exposed to hydrazines in the workplace. Such records shall be kept for at least 30 years after the last occupational exposure to hydrazines. Records of environmental exposures applicable to an employee shall be included in the employee's medical records. These records shall be made available to the designated medical representatives of the

Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

Section 3 - Labeling and Posting

All labels and warning signs shall be printed both in English and in the predominant language of non-English reading workers. Workers who cannot read the language used on labels or posted signs shall receive information regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

All shipping and storage containers for hydrazines shall be labeled, and all areas where any hydrazines are stored, produced, used, or processed shall be posted in accordance with the following paragraphs.

(a) Containers of hydrazines shall bear the following label in addition to, or in combination with, labels required by other statutes, regulations, or ordinances.

(Name of Compound)
(Tradename, Chemical Name, Common Name)

DANGER!
EXTREME HEALTH HAZARD
MAY CAUSE CANCER
MAY BE ABSORBED THROUGH SKIN

Keep container closed.
Avoid contact with skin and eyes.
Avoid breathing air contaminated with this substance.

First Aid: In case of contact, immediately flush with copious amounts of water. Obtain prompt medical attention.

Containers of hydrazines that are considered flammable or combustible shall also bear the following label:

FLAMMABLE (or COMBUSTIBLE)

Keep away from heat, spark, open flame, and oxidants.

Containers of material contaminated with hydrazines, including those holding clothing or animal carcasses, shall bear the following precautionary label:

CAUTION

MATERIAL CONTAMINATED WITH
CANCER-SUSPECT AGENT
(Name of Compound)

(b) The following warning sign shall be posted in readily visible locations where hydrazines are stored, produced, or used, particularly at the entrance to the areas.

WARNING
CANCER-SUSPECT AGENT

(Chemical Name) USED IN THIS AREA
AUTHORIZED PERSONNEL ONLY

Avoid breathing air contaminated with this substance.
In case of contact, flush with copious amounts of water. Wash clothing before reuse. Obtain prompt medical attention.

If respiratory protection is required in accordance with Section 4, the following statement in large letters shall be added to the required sign:

RESPIRATORY PROTECTION REQUIRED IN THIS AREA

Where the presence of hydrazines could result in a fire hazard, the sign shall also contain the following information:

FIRE AND EXPLOSION HAZARD

Section 4 - Personal Protective Clothing and Equipment

All systems or equipment containing the hydrazines shall be designed to minimize the possibility of vapor or aerosol inhalation, skin or eye contact, and spills or leaks. When necessary, these controls shall be supplemented by the use of personal protective clothing and equipment.

(a) Protective Clothing

(1) The employer shall provide full-face shields (8-inch minimum) and goggles which shall be worn during any operation in which there is a reasonable possibility that hydrazines may enter the eyes or splash onto the face.

(2) The employer shall provide full-body protective clothing, including gloves and boots, and shall ensure that employees wear this clothing when spills or splashes of hydrazines may occur, such as during repair or during transfer operations.

(3) Gross contamination shall be removed from protective clothing before the clothing is taken off the wearer.

(b) Escape Equipment

Emergency equipment shall be located at well-marked and clearly identified stations and shall be adequate to permit all personnel to escape from the area.

(c) Respiratory Protection

Respirators may be used only when engineering controls are being installed or tested, during nonroutine maintenance or repair, in emergencies that may involve brief exposure in excess of the recommended limits, or for entry into confined spaces. In the situations listed above, employees exposed to 1,2-dimethylhydrazine shall wear a respirator. When use of a respirator is permitted, it shall be selected and used in accordance with the following requirements:

(1) The employer shall provide respirators in accordance with Table I-1 and shall ensure that, when required, they are properly used. The respiratory protective devices provided in conformance with Table I-1 shall be those approved by NIOSH or the Mining Safety and Health Administration (MSHA). The standard for approval is specified under the provisions of 30 CFR 11.

(2) The employer shall ensure that employees are properly instructed in the use of respirators assigned to them and on how to test for leakage, proper operation, and proper fit as judged by quantitative fit tests.

(3) The employer shall provide for the cleaning, sanitizing, inspecting, maintaining, repairing, and storing of respirators and shall ensure that employees are provided with clean respirators that are in good operating conditon.

(5) Protective equipment suitable for emergency entry or reentry shall be located at clearly identified stations outside the work areas.

TABLE I-1

RESPIRATOR SELECTION GUIDE FOR HYDRAZINES

Concentration of Hydrazines	Respirator Type Approved under Provisions of 30 CFR 11
Greater than the environmental limits specified in Section 1*	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode (2) Combination Type C supplied-air respirator with full facepiece and auxiliary self-contained air supply operated in pressure-demand mode
Emergency entry or entry into a confined space	Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode

*or exposure to 1,2-dimethylhydrazine as specified in this section

Section 5 - Informing Employees of Hazards from Hydrazines

(a) At the beginning of employment and at least annually thereafter, the employer shall provide training, supplemented by written information, on the hazards of hydrazines to employees exposed to them.

(b) The employer shall institute a continuing education program, conducted by persons qualified by experience or training, to ensure that all employees have current knowledge of job hazards, proper maintenance and cleanup methods, and proper respirator use. The instructional program shall include a description of the general nature of the environmental and medical surveillance procedures and of the advantages to the employees of participating in them. As a minimum, instruction shall include the information in Appendix II, which shall be kept on file and be readily accessible to employees assigned to work areas where there is occupational exposure to hydrazines.

(c) Required information shall be recorded on the "Material Safety Data Sheet" shown in Appendix II or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Control of Airborne Hydrazines

Engineering controls, such as process enclosure or local exhaust ventilation, shall be used when needed to keep concentrations of airborne hydrazines within acceptable levels. Ventilation systems shall be designed to prevent accumulation or recirculation of airborne hydrazines in the workplace environment and to remove hydrazines from the breathing zone of workers. When needed, moving parts shall be sparkproof. Such systems should also be designed to operate under negative pressure to prevent leaks into the work environment. Enclosures, exhaust hoods, duct work, and fans shall be checked periodically, and preventive maintenance and cleaning

shall be performed when necessary to ensure their integrity and proper operation. Airflow at each hood shall be measured at least every 3 months to ensure that design airflow is maintained. A log shall be kept showing design airflow and the results of quarterly inspections. Continuous airflow indicators, such as water or oil manometers, mounted at appropriate points and marked to indicate acceptable airflow are recommended. All adjustments to the ventilation system should be made by authorized maintenance personnel. Before maintenance work on control equipment begins, sources of contamination from hydrazines shall be eliminated to the extent feasible. Exhaust ventilation systems discharging to outside air shall conform with applicable local, state, and Federal air pollution regulations and shall not constitute a hazard to employees or to the general population.

(b) Regulated Areas

Regulated areas shall be established and maintained where the hydrazines are stored, produced, or otherwise used, and access to these areas shall be limited to authorized persons. A log shall be kept of those entering such areas.

(c) Laboratory Activities

When hydrazines are used in laboratory activities, the following provisions, in addition to other sections, shall be followed.

(1) Mechanical pipetting aids shall be used for all pipetting procedures.

(2) Experiments, procedures, and equipment that could produce aerosols or vapors of hydrazines shall be confined to laboratory-type hoods, glove boxes, or other similar control apparatus. Exposure

chambers and associated generation apparatus shall be separately ventilated.

(3) Surfaces on which the hydrazines are handled shall be impervious to absorption or penetration by these hydrazines.

(4) Laboratory vacuum systems shall not be connected to nonregulated areas. These vacuum systems, hoods, and exposure chambers shall be exhaust ventilated in a manner consistent with Federal and local air pollution regulations.

(5) Airflow in the laboratory shall be established in such a pattern as to flow from the least to the most contaminated area. Contaminated exhaust air shall not be recirculated or discharged to other work areas, regulated or nonregulated.

(d) Work Clothing

(1) Employees, including animal handlers, working in regulated areas shall wear coveralls, head, foot, and shoe coverings, and gloves.

(2) Laboratory employees working in regulated areas shall wear appropriate laboratory clothing, such as a solid-front gown, surgical scrub suit, or fully buttoned laboratory coat, and head, foot, and shoe coverings and gloves.

(3) Employees shall remove work clothing when leaving regulated areas. After the last use in a workshift, work clothing shall be placed in a properly labeled, airtight container for decontamination or disposal.

(4) Work clothes shall be changed daily or when accidentally contaminated by the hydrazines.

(5) The employer shall provide for laundering of this clothing and shall ensure that soiled work clothing is not taken home by the employee. Precautions shall be taken to protect personnel who handle and launder soiled clothing. These workers shall be advised of the hazards of exposure to hydrazines and the means of preventing such exposure.

(e) Hygiene

Good personal hygiene practices shall be required. Employees leaving regulated areas shall wash their hands, forearms, face, and neck, particularly before eating and smoking or using toilet facilities. When work for the shift is completed, the employee shall shower and leave the regulated area.

(f) Disposal of Waste

Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. Contaminated wastes and animal carcasses shall be collected and stored in impervious containers. The containers shall be closed and the outer surface decontaminated before removal from the work area. In selecting the method of waste disposal, applicable local, state, and Federal regulations should be consulted. If the waste is incinerated, release of hydrazines shall be prevented.

(g) Storage and Handling

All hydrazines should be stored at temperatures well below their boiling points. Hydrazines that are ignitable shall be stored in electrically grounded containers and isolated from ignition sources and oxidants. All containers of hydrazines shall be kept tightly closed when not in use and stored in a cool ventilated room or sheltered outside space. In the containers, a blanket of nitrogen or other inert gas should be

placed over the hydrazines. Containers shall be emptied so that the possibility of spills and the escape of airborne hydrazines are minimized.

(h) Entry into Confined Spaces

Entry into confined spaces, such as tanks, pits, tank cars, and process vessels, that have contained hydrazines shall be controlled by a permit system. Permits shall be signed by an authorized employer representative, certifying that preparation of the confined space, precautionary measures, and personal protective equipment are adequate and that the prescribed procedure will be followed.

(1) All lines shall be disconnected or blocked while the vessel is being cleaned. All valves or pumps leading to and from the vessel shall be locked out or tagged out.

(2) The vessel shall be either washed with water and purged with air, or purged with nitrogen and then with air.

(3) The vessel shall then be checked by trained personnel for fire or explosion hazard, airborne hydrazines, possible oxygen deficiency, and concentrations of other likely contaminants, to assure that no danger exists.

(4) If a respirator is necessary, a self-contained breathing apparatus as specified in Table I-1 shall be provided to the employee.

(5) Each employee entering the vessel shall be equipped with appropriate respiratory protection, a harness, and a lifeline. At least one other person equipped with appropriate respiratory protection, harnesses, and lifelines shall watch at all times from the outside. At least two more persons should be available to assist in an emergency.

Mechanical ventilation shall be provided continuously when workers are inside the vessel.

(i) Emergency Procedures

For all work areas where there is a potential for emergencies involving hydrazines, employers shall take all necessary steps to ensure that employees are instructed in and follow the procedures specified below and any others appropriate for the specific operation or process.

(1) Instructions shall include designation of medical receiving facilities and prearranged plans for immediate evacuation of employees exposed to or in contact with hydrazines, for any necessary calls for assistance, and for reentry for repairs or cleanup of areas where leaks or spills of hydrazines have occurred.

(2) Telephone numbers for emergency assistance shall be prominently posted.

(3) Employees not essential to emergency operations shall be evacuated from hazardous areas during emergencies.

(4) Personnel inadequately protected against the attendant hazards shall not shut off sources of hydrazines, clean up spills, or control and repair leaks. Spilled hydrazines shall be stabilized with a dilute acid such as acetic or hydrochloric acid, flushed into a holding tank, and inactivated with dilute hypochlorite or another oxidant.

(5) Eye, skin, and approved respiratory protective devices, specified in Section 4, shall be used by personnel essential to emergency operations.

(6) Fire shall be extinguished by coarse sprays of water, when appropriate. Advanced or large fires shall be fought from a safe distance or from a protected area.

(7) Hydrazines in contact with skin or eyes shall be immediately flushed away with copious quantities of water, and medical attention shall be obtained promptly.

Section 7 - Sanitation

(a) The preparation, storage, dispensing (including vending machines), or consumption of food shall be prohibited in regulated areas.

(b) Smoking shall be prohibited in regulated areas.

(c) Employers shall provide emergency showers and eyewash fountains, with adequate pressure of water, that are quickly accessible in areas where hydrazines may contact the skin or eyes. This equipment shall be kept in good working condition and shall be inspected frequently.

(d) Conveniently located washing facilities shall be provided for all employees who work in regulated areas. Locker room facilities, including showers, shall be located in nonexposure areas. Employees shall be required to change from street clothes before entering regulated areas. The locker room facilities shall provide for storing street clothing and clean work clothing away from soiled work clothing. Airtight containers shall be provided for storage and segregation of contaminated work clothing. The clothing shall be held in these containers until it is removed for decontamination or disposal.

Section 8 - Monitoring and Recordkeeping

(a) Industrial Hygiene Surveys

Each employer who has a place of employment in which any of the hydrazines are stored, produced, processed, or otherwise used shall determine by an industrial hygiene survey the areas in which occupational exposure occurs. Records of these surveys shall be retained until the next survey has been completed. If an employer concludes that there is no occupational exposure to hydrazines, the records shall show the basis for this conclusion. Surveys shall be repeated at least annually and within 14 days after any process change likely to result in occupational exposure to hydrazines.

(b) Personal Monitoring

If it has been determined that occupational exposure to hydrazines (other than 1,2-dimethylhydrazine) occurs, the employer shall institute environmental monitoring.

(1) A program of personal monitoring shall be instituted to identify and measure, or permit calculation of, the exposure of each employee. Source and area monitoring may be used to supplement personal monitoring.

(2) In all personal monitoring, samples representative of the exposure in the breathing zone of the employee shall be collected.

(3) For each determination of the concentration of hydrazines, a sufficient number of samples shall be taken to characterize the employee's exposure. Variations in the employee's work and production schedules, location, or duties, and changes in production schedules shall be considered in deciding when samples are to be collected.

(4) Each operation in each regulated area shall be sampled at least once every 6 months while hydrazines are being used. For intermittent operations, ie, lasting for less than 6 months, at least one monitoring regimen shall be conducted during each operation period. If an employee is found to be exposed to the hydrazines at concentrations exceeding the recommended ceiling limits, the exposure of that employee shall be measured at least once every week, control measures shall be initiated, and the employee shall be notified of the exposure and of the control measures being implemented. Such monitoring shall continue until two consecutive determinations, at least 1 week apart, indicate that the employee's exposure no longer exceeds the recommended occupational exposure limit; routine semiannual monitoring may then be resumed.

(c) Recordkeeping

Records of environmental monitoring and pertinent medical records shall be kept for at least 30 years after the employee's last occupational exposure to hydrazines. Records of environmental monitoring shall include an identification of the employee being monitored, duties and job locations within the worksite, time and dates of sampling and analysis, sampling and analytical methods used and available evidence of their precision and accuracy, the number, duration, and results of samples taken, environmental concentrations determined from these samples, and the type of personal protective equipment used by the employee. Rosters of authorized persons who enter regulated areas shall also be retained for 30 years. Environmental monitoring records and entry rosters shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare. Employees shall have access

to data on their environmental exposures. Copies of records of environmental exposures applicable to an employee shall be included in the employee's medical records. These medical records shall be made available to the designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing impairment of health from exposure to the hydrazines. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare under Section 20 (a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

NIOSH, after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health and to provide for the safety of employees exposed to hazardous chemical and physical agents. The criteria and recommended standard should enable management and labor to develop better engineering controls resulting in more healthful work environments and simply complying with the recommended standard should not be the final goal.

These criteria for a standard for hydrazines are part of a continuing series of criteria developed by NIOSH. The proposed standard applies to the processing, manufacture, handling, storage, and use of the hydrazines. The standard was not designed for the population-at-large, and any extrapolation beyond occupational exposures is not warranted. It is intended to (1) protect against injury from hydrazines, (2) be measurable

by techniques that are valid, reproducible, and available to industry and government agencies, and (3) be attainable with existing technology.

The recommended exposure limits for hydrazines are based on the conclusion that these substances are likely to be carcinogenic to humans. This evidence is especially strong in the case of hydrazine and 1,2-dimethylhydrazine but is persuasive in regard to all the compounds.

Although full information is not available on each of the hydrazines, compounds of this group clearly produce toxic effects on the liver, the kidneys, and blood, the severity and type of response being dependent on the individual compound. In some cases, these effects are so severe as to warrant a low environmental limit even without consideration of carcinogenicity. In addition, these compounds are acutely toxic, producing effects on the central nervous system (CNS) that are manifested by convulsions and other less severe signs. Finally, hydrazines are local irritants to the skin and eyes, and systemic toxicity can result from such exposures. NIOSH considered these other effects, as well as carcinogenicity, in deriving a recommended standard for the hydrazines. Particular attention was also given to limit dermal contact with the hydrazines, a potential source of exposure.

At this time, no environmental limit is being recommended for 1,2-dimethylhydrazine, since an acceptable analytical method has not been found. 1,2-Dimethylhydrazine is a potent carcinogen in animals, and its use is apparently limited to the study of colon cancer.

Inhalation studies are needed to determine the potential carcinogenicity of the hydrazines by a route more appropriate to workplace exposure. Such studies are currently in progress for three of the

compounds, and the applicable recommendations will be considered for review and revision, as necessary, when this information becomes available. Little information exists for phenylhydrazine, in particular, on either its carcinogenicity or other effects. Much of this information is primarily of historical interest and needs to be reconfirmed by more modern studies. The impurities resulting from manufacture and decomposition of hydrazines, their role in toxicity, and their carcinogenicity also need to be investigated.